

portioning of the size of the air inlet holes and of the gas injector, thus causing a perfect mixing of the air and gas for combustion. The lower part of the burner is constricted and the upper part enlarged so as to allow a thorough mixing of the gas and air before combustion. The top part of the burner is furnished with a deep nickel grid to prevent back-flashing of the flame. This nickel grid is of very stout make, and is about 1 cm. deep, thus making it practically impossible for the flame to flash back. Although the burner gives a very hot flame, the amount of gas used is by no means excessive, and as metals are very rapidly melted, and other operations, such as fusion and reduction, carried out very quickly, the gas consumption for a given operation is less than with other burners.

One of the greatest advantages is that, by using the Méker burner, operations which used to require a large amount of leg-work with the blow-pipe can now be carried out without employing a blow-pipe at all. In order to obtain very high temperatures another form of the Méker burner is arranged for use with the blow-pipe or compressed air.

These burners are made in a large variety of sizes and shapes, and from our experience with them we shall expect to see them largely employed in the future.

THE DEFECTS OF ENGLISH TECHNICAL EDUCATION AND THE REMEDY.¹

WHEN writing the paper which I am going to read to you I have rarely been free from the oppressive thought that many of my audience will justly consider it forwardness, bordering even on arrogance, on my part to lecture to an association of English technical teachers on the defects of English technical education. Not only have I been interested in this subject merely for a few years, whereas many of my audience have spent a lifetime in it, but I am not an Englishman myself.

Your secretary, however, insisted that the exceptional opportunities which I have had of becoming acquainted with technical education as it affects, not only the lecturer and the student, but also the employer of labour, in this country as well as in Germany, would carry weight with you and would assure your serious consideration of my views; but further, standing as I do outside the teaching profession, and having no private interests to serve, I thought that, whatever criticism I might experience, I should not be suspected of any ulterior motive if I came forward to point out what, to my mind, are the weaknesses and faults of our present system, and to advocate what appears to me the only right course to adopt. So I accepted your secretary's invitation, and will, with your permission, now proceed to place my somewhat unconventional views before you.

The importance of technical education for any modern nation, but most particularly for England, cannot easily be overestimated, a fact which is being pointed out so frequently and acknowledged so generally that I need not dwell upon it at any length. There is not a student of national economy who fails to realise that Germany and the United States, now serious rivals to English trade, owe their rapid industrial and commercial development largely to the magnificent system of technical education which they have established.

Indeed, the recognition of this fact by all thoughtful men has led to vigorous efforts being made during the last ten years or so, and to a prodigious amount of money now being annually spent in this country for the purposes under discussion.

No one will deny that a very great deal has been accomplished, and personally I should be the last to underestimate the value of the work now being done in numerous institutions, or to belittle the services of so many pioneers, to whom, indeed, the nation owes a debt of gratitude. Nevertheless, it must be, and is, widely recognised that technical education is only in its infancy, that it is as yet far from exercising to the full and in an efficient

manner that propelling influence on the industries of the country which is its aim and duty.

Almost invariably, however, when this fact is recognised and pointed out, on whatever occasion it may be, the conclusion is drawn from it that the people of England must be prepared to spend more money in erecting and thoroughly equipping technical colleges and universities.

The main object of this paper is to prove the fallacy of that conclusion, and that every new college erected is another stone round the neck of technical education. It is, in my opinion, certainly not lack of money which is to blame for the admittedly unsatisfactory state of affairs. From the statistical data contained in the Government Blue-books and Budgets I have made a calculation as to the total expenditure of public money in England and Wales as compared with Prussia. The two countries are similar in industrial activity and in the character of their population. Prussia, with its highly efficient educational system and its technical institutions admired by all the world, spends roughly 600,000l. per annum on current expenditure. The statistics available for England, particularly as to local contributions, are rather scanty, but from a very moderate estimate I find that at least 1,000,000l. is annually spent for equivalent purposes. Taking into account the larger population of Prussia, we arrive at the result that England already spends about twice as much money as Prussia, reckoned per head of population, with educational results which—I say it without hesitation—will not bear any comparison. If one would compare the extraordinary expenditure incurred in building and equipping new institutions, the result, I believe, would be even more unfavourable to England.

Neither lack of money nor of effort is the fault, but the fundamental principle is wrong on which rests the whole structure of technical training in this country.

Technical education is not a private or local, but by its very nature a national affair, and the most essential condition for efficiency and economy is that it should be established on the basis of systematic national organisation, and that it should be nationally managed.

The numerous objections raised by employers and the general public against technical colleges, and the still more numerous grievances of those actively engaged in technical training, are largely, if not solely, connected with the present unsound foundation.

With the object of proving the truth of these sweeping statements, let us briefly consider what are the complaints I refer to.

(1) The number of day students in all institutions, and consequently the attendance at the majority of classes, is far too small. Taking the figures given by the British Education Section of the Franco-British Exhibition for 1908, there were in England and Wales forty-five technical and agricultural colleges, with a total attendance of 3344 day students. This corresponds to an average of seventy-five students per college, or approximately six students per class. These figures do not include the technical students of universities and university colleges, but, nevertheless, the facts are even worse, because the large number of smaller technical institutions providing for day instruction is omitted from the list, and the preponderance of students in the first-year courses must also be kept in mind; and, further, even in the largest colleges, in such institutions as the Birmingham University and the Manchester Municipal School of Technology, the attendance of day students bears no proportion to the cost of their beautiful equipments. Manchester, for instance, reports a total attendance in all departments of 165 full-course day students during the present session. In numerous institutions it is by no means an exception to find classes, especially in more advanced subjects, consisting of two or three students, and many classes only exist on paper, there being no students at all to take advantage of the facilities offered to them.

(2) The average education of day students entering for technical instruction is poor, and the diversity of their previous training so great, that the gravest educational difficulties result. This is only partly due to the unsatisfactory state of primary and secondary education. The

¹ Paper read before the Association of Teachers in Technical Institutions (West Yorkshire branch) in Huddersfield, on March 27, by Dr. Robert Pohl.

chief reason is the scarcity of students, which leads to little regard being taken of the previous education of a would-be day student.

(3) The undue importance attached to external examining bodies, and the consequent variety of examinations to which the training must be adapted, detract from a concentration of effort and uniformity of purpose.

(4) The usual management of municipal institutions by a committee, the constitution and policy of which may change every year, and which only too often consists of a number of private gentlemen more or less strangers to technical education, is unsound and wasteful. It often stultifies the really enthusiastic teacher by delaying necessary and urgent improvements.

How long will this country continue to leave the management of so vital a matter as day technical education largely in the hands of amateurs?

(5) The equipment provided in individual institutions cannot be kept up-to-date, owing to lack of funds and of students.

All these serious obstacles result in financial wastage as well as educational inefficiency, the latter all the more, as they make it exceedingly difficult for a teacher to find that amount of satisfaction in his work necessary to keep alive his enthusiasm and that of his students.

Coming to the attitude of the employers of labour toward technical education, it is not altogether surprising to find that little importance, as a whole, is attached to college training.

A comparison of the advertisements for vacant posts appearing in English and German technical papers will prove this better than anything else.

Generally speaking, there appears to be amongst employers a lack of interest in technical education, and not much willingness to cooperate with technical institutions. This impression I have received in numerous conversations and inquiries concerning this subject. Specific complaints there are few; I have occasionally heard it stated that day technical training is not of a sufficiently practical character, that day colleges not rarely fail sufficiently to impress on the minds of the students the importance of practical experience, and that, thereby, they indirectly make them look down on shop-trained men and unwilling to adapt themselves to the routine of the workshop and to acquire practical knowledge and skill; that technical teachers are often recruited from the ranks of those day students who have found it too difficult a task working themselves up to a good position in practical life; this, in turn, is said to be the cause of the colleges remaining alienated from practice. Finally, the statement is sometimes made that too little original work, especially such as requires experimental research, is carried out by the staffs of day colleges.

My personal opinion as to these points is that none of them is quite without justification, though specific cases are often exaggerated and unduly generalised. It is certainly a great mistake permitting students to remain as assistants in the college after their final examination, and gradually to work themselves up into the position of lecturers in technical subjects, without having ever entered into practical life.

The main cause for such complaints, however, lies in the fact that even in the technical universities the number of students is not sufficient to permit of a number of specialised experts being appointed in each department, as is the practice in Germany. The professor or lecturer in an English college is expected to deal with a variety of subjects, each of which is a science in itself, and his spare time is very limited. Personally, I think it is surprising that so much original work is done in spite of such adverse circumstances.

Evening classes stand in greater favour with employers, being considered a necessary complement to the day-work of apprentices. Complaints are made, however, on account of the heavy nervous strain imposed on youths. Only quite recently two cases of nervous collapse have come to my notice which, according to the doctor, were without doubt due to excessive strain imposed by the college work, which consisted of lectures on three nights a week and a large amount of home-work. Proper cooperation between the employer and the college would have secured the amount of relief during daytime necessary for the physical

and mental well-being of the boy. Such cooperation is absolutely necessary in connection with all evening work.

Coming, finally, to the general public and its attitude towards technical education, I need hardly refer to the cry heard throughout the length and breadth of the land that the technical schools impose a far too heavy burden on the ratepayer, a burden altogether out of proportion to the work accomplished, both qualitatively and quantitatively. We hear that cry every day. I am afraid, however, of losing your sympathy altogether when I state it as my opinion that these complaints of the ratepayer are fully justified. I consider some of the figures which were recently published as to the cost of technical education per student-hour are absurdly high, and a conclusive proof of the inefficiency of our present system; but, apart from that consideration, the ratepayer contributes about 75 per cent. of the cost of technical education, whereas it is only just that the bulk of it should come from national sources.

This list of defects of technical education could be still further extended, but I have only referred to the most important ones, the majority of which are felt in all technical schools and colleges, and on which I believe we are agreed.

Now, I venture to submit to you that all these defects could be removed by placing technical education on a national basis.

Day technical teaching, to be efficient, must, in my opinion, be thoroughly organised all over the country, so that a limited number of excellently equipped colleges, with a very large number of students and a corresponding number of specialised lecturers in each department, will satisfy the needs of their correspondingly large districts. That is the secret of Prussia's success; and though many English people, justly proud of their free institutions, may look down on Prussia as a State governed by army officers and policemen, so much they will have to admit, that England not only can, but must and will, learn a good deal from Prussia in regard to the organisation of education.

May I, for example, refer to the Charlottenburg College, about which so much was said and written in connection with the founding of the Imperial College of Science and Technology? Very rarely have I found that the English admirers of Charlottenburg understood the real difference between the German and any corresponding British technical college. It is this: technical education being nationally organised in Prussia, there exist only four technical universities in the whole country, with a population of 38,000,000 people. The average number of day students is about 2500 per day. Charlottenburg, the largest of them, is the technical university, not only for the whole of Berlin, but in addition for a district of some 40,000 square miles. The number of its students, which, of course, are all day students, is about 5000, and the most stringent regulations as to their previous training are in force. With such an attendance the State can afford to appoint for each department a number of professors, each of whom is a recognised authority in some branch of that department. As an example I may mention that there are at Charlottenburg not less than seventeen professors and lecturers in electrical engineering subjects alone.

Instead of this, what do we find in England? The British Government has chosen the easier course of leaving the founding and management of technical institutions to the enterprise of charitable private persons, corporate bodies, and the local authorities. As a result, there are—not in greater London, but in the administrative County of London only—at least six colleges of university standing and six day colleges recognised by the Government as technical institutions competing with one another, not to mention ten other institutions with day technical classes and eighteen schools of art. Similarly, in the provinces quite a number of lavishly equipped university colleges have been founded, and technical day schools have sprung up like mushrooms, their number now being many times in excess of the well-understood needs of the country. Many of these institutions are in close proximity to and competing with one another.

The educational consequences require no repetition. You may go through all the defects which we have considered, and you will easily see that every one of them is directly attributable, not to lack of energy or ability on the part

of the technical teacher or to unwillingness of the British rate- and taxpayer to part with his money, but to the absence of national organisation and the consequent disastrous competition between the existing schools.

Money can build the most beautiful edifices and buy the most excellent equipments, but it will not cure this evil. Technical education will, in my opinion, never to the full exercise its highly important functions in the life of the nation until the Board of Education awakens to its duty and establishes a sound national system of technical education; and such system will require to be enforced, as the petty jealousies invariably found to exist between neighbouring corporations do not permit of any hope that a similar result may be obtained by voluntary cooperation.

To this you will reply that the establishment of a national system of technical education would be a revolutionary and almost impossible step in England. I beg to disagree, and to believe that technical education can be far more easily organised on the basis of a national system than, for instance, primary education. In fact, I even doubt as to whether any new legislation would be required for the purpose. The pressure which the Board of Education, by means of the grant alone, can bring to bear on the governing bodies will prove sufficient to bring the majority, if not all, of the existing schools into line with a national scheme, and to make them take up the position assigned to them in it. I will go further, and venture to prophesy that before many years have passed the Government will have to take this matter up, under the combined pressure of the two parties chiefly interested in efficiency and economy, *i.e.* the technical teacher and the ratepayer.

It will, on this account, not be a waste of time to consider briefly the question as to an ideal system for England. I am well aware that any such system could only very gradually be developed out of the present chaos. A definite, practical scheme, however, even if not fully attainable, always serves as an invaluable and unfailing guide.

Naturally, opinions on this question will differ very greatly, and all I have to say must be taken merely as a suggestion towards a very careful and exhaustive investigation of the subject, which, I think, this association ought to carry out.

Let me state, first of all, that I should not recommend an imitation of any existing foreign system, not only because I am unaware of any system that could not be materially improved upon, but chiefly because the educational system of any country must, of course, be adapted to its particular industrial and educational conditions; and, again, far from condemning the present English system root and branch, I consider that some of its features are most excellent, and should be maintained and further developed—features which are entirely absent, for instance, in the Prussian system. I refer, first, to the evening courses, which are doing exceedingly good work, and are deserving of the highest praise, and, secondly, to its democratic spirit, which shows itself in the low fees for evening instruction and in the extensive system of scholarships. I am well aware that complaints are often voiced against the methods now adopted in the awarding of scholarships, to the effect that they do not effectively prevent the tremendous leakage in the nation's brain resources. Still, I think it will be possible to modify it in such a manner as really to detect the very best brains of the whole country, wherever they may be found, and to lead them up to the highest possible development, to the benefit, not only of themselves, but of the whole nation. These factors, I suggest, should form two of the corner-stones of a national system.

However, in discussing these matters we are really taking the second step before the first. Before erecting corner-stones we ought to remember that no superstructure, however well designed, can stand erect unless it rests on sound foundations; and this leads me to what is perhaps the most important consideration in connection with this subject.

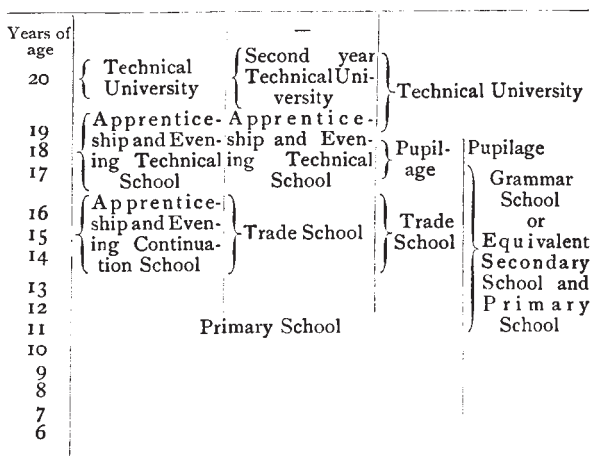
Unless English primary education is put into a much more satisfactory condition, technical education must remain severely handicapped. Does it not almost amount to

a national crime that many thousands of children are permitted to leave school when only twelve years of age, and when the instruction is just becoming most valuable? Words fail in face of such overwhelming evidence as is contained, for instance, in a report of the Huddersfield Education Committee, issued a few months ago, of which the following is an extract:—"His Majesty's Inspector conducted a labour certificate examination. 162 candidates were examined, 136 passed and 26 failed. Of those who passed, 125 were between the ages of twelve and thirteen, and only 11 were over thirteen years of age." It is the duty of this association and of all individual technical teachers to work for the final abolition of the half-time system, the extension of the age limit for compulsory school attendance to fourteen years, and also for the stopping of street hawking and other exploitations of child labour. All men interested, not in cheap labour, but in the well-being of the nation, are agreed upon the desirability, and even the absolute urgency, of these reforms. Surely if other and less wealthy nations can afford carefully to educate every future citizen until he or she be at least fourteen years of age, England would not overtax her resources by doing likewise; indeed, she would make a step towards true economy.

A Children's Bill was passed during the last session of Parliament containing, I admit, some excellent provisions; but it passes my comprehension how the Government can be as proud of its "Children's Charter" as it seems to be so long as no attempt whatever is made towards the above indicated reforms, so highly important and so long overdue.

In addition to the extension of the school age, primary education should, in my opinion, be rounded off by compulsory attendance at evening continuation schools for three years.

On the basis of sound primary education, the structure of technical training which I wish to suggest is as shown in the following diagram, which indicates the various ways leading up to the technical university:—



A boy of fourteen, leaving the primary school and wishing to go in for a technical trade, has two courses open to him. If his parents cannot afford to let him continue in the day school, he should be apprenticed and should attend the evening continuation school up to his seventeenth year. He may then obtain a more specialised technical education, according to his requirements, by attending the technical evening classes for another three or four years, proper cooperation with the employers being an essential condition if success is to be obtained; and should his teachers find that his is a brain of exceptional ability, deserving and desiring to be developed as highly as possible, I suggest that an extensive system of national maintenance scholarships should enable him then to enter the technical university.

This is not the place to discuss the details of conditions and requirements. I only wish to emphasise that the son

of even the poorest parents should not, by reason of his leaving school at fourteen, lose his opportunities of reaching the very top of the educational ladder; and I am anxious to lay the greatest stress on the desirability of extensively drafting the very best evening students into the technical universities.

The second alternative for the boy of fourteen is to continue his school life in a trade school to his seventeenth year, when the final certificate will give him access to the technical university after an apprenticeship or pupilage of at least one, better two, years. This would be the easiest and the more general road to the technical university; but, again, on leaving the trade school the student may be apprenticed for three years, attending also the evening classes, and he may qualify for the second year of the technical university, or even obtain a maintenance scholarship.

The third way of reaching the technical university would be through the grammar school or equivalent secondary schools. The certificate of having passed a certain standard either on the modern or the classical side would, again, without further entrance examination, be accepted as sufficient proof of adequate education, though for engineering, building, and textile departments at least one, but preferably two, years' practical work should precede the university studies.

The above forms an outline, though a very rough and compressed one, of my ideas. Let us, in conclusion, consider the most important question as to how the general introduction of any such national scheme would affect existing schools, and also the position of the technical teacher.

The majority of the existing technical day institutions would cease to exist as such; they have given conclusive proof that they have no right of existence. They would be transformed into trade schools for the daytime. The evening technical classes, however, would not only be maintained, but further developed, as they would grow enormously in general importance.

A number of the existing colleges and universities, spread at sufficiently large intervals over the country, would be developed into technical universities of the highest order, challenging comparison, not only as regards equipment, but in every other respect, with the very best institutions of other nations. According to the nature of the district, such technical university might be split up, where necessary, and an engineering college be established in one centre, a textile college in another, a mining college in a third, &c. Thus regard could be paid to local requirements to a considerable extent, while at the same time abolishing the present disastrous multiplication of efforts. The technical university should in its management be independent of local authorities; it should be entirely self-governing, and be under the direct control of the Board of Education. It should be permeated by a thoroughly democratic spirit, and those recruited from the technical evening classes by means of maintenance scholarships should form a very large percentage of its students.

Now, as to the position of the technical teacher, will it suffer or improve under such a scheme?

The answer is obvious if we will only consider what it is at present. The technical teacher is overburdened with day and with evening work, in addition to which, as is well known, he must spend a great deal of spare time in private study if he wishes to keep up to date in his rapidly progressing subjects; but, in spite of this, his salary, on the whole, is hardly better than that of the elementary teacher. In the endeavour to economise at all costs, corporations seem more and more inclined to consider the salaries of technical teachers as the most appropriate subject for curtailment; and, further, it seems to me, the technical teacher does not stand very high in the estimation of either the general public or the employer of labour.

Summing up, I find that his position is far from being in accordance with the importance of his work with regard to the life and development of an industrial nation. The reason is obvious. As yet technical education itself occupies a position far below that which is its due, and, of course,

the technical teaching profession is inseparably connected with it. By lifting technical education up to its proper level and making it a national affair you would make the technical teacher a national or, to use the ordinary term, a Civil Servant, and the technical teaching profession would receive the recognition which it deserves, and which it receives in other countries.

That is, in my judgment, the only way in which English technical Education may be enabled to exercise that amount of guiding and enlightening influence which it must possess if this industrial country wishes to maintain its front seat in the council of the nations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

At a meeting of the East Lancashire Branch of the Association of Teachers in Technical Institutions on April 17 at the Municipal School of Technology, Manchester, Prof. W. W. Haldane Gee will open a discussion on "The Optical Lantern and the Microscope, with Special Reference to their Educational Uses."

DURING the last three years an investigation has been in progress in the United States to trace the cause of the failure of the physics teaching in the secondary schools of the country, and the educational journals have devoted much space to the question. It now seems possible to give a summary of the most important facts which the inquiry has brought to light. When physics was first introduced into American secondary schools, a distinct effort was made to present it as a means of explaining the various natural phenomena witnessed by the pupil in his daily life. Few experiments were performed, and those by the teacher with the simplest possible apparatus. Then came the decree that methods must be changed so as to meet the requirements of college entrance examinations, and, as a result, pupils were on the one hand forced into "inductive" or first-hand work, for which they were quite unsuited, and on the other were overwhelmed with mathematical formulæ, in which the physics was buried past disinterment. Now there is a strong desire to return to the ideals which prevailed in the past, to sever the school teaching from college control, to reduce the emphasis now laid on mathematical formulæ and on extreme accuracy in experimental work, and to base the subject on the daily experience of the pupils. The national commission has our cordial support in its efforts at reform.

THE March number of the *Psychological Bulletin* is devoted to child and educational psychology. Prof. O'Shea writes of progress in this field, and puts his finger definitely upon the necessity for the establishment of institutions for educational research in which children of every age will be available for observation and experiment. There are many psychological laboratories, but no institution in which the resources of the experimental psychologist are solely devoted to the problems of the teacher. Perhaps the nearest approach to this ideal is to be found in Leipzig, where the enterprise of the teaching profession has established a centre for scientific research into those unknown forces with the behaviour of which the schoolmaster is expected to have expert knowledge. Prof. Bagley's article, on the psychology of school practice, gives an excellent summary of recent work in this field, and admits the importance of the evidence, which is steadily accumulating, in favour of the doctrine of formal training, albeit in a form less crude than that against which the Herbartian has always tilted. The survey of work in Germany, France, and elsewhere is useful, though the omission of the name of Binet from that part which deals with French activity in this direction is surprising. Prof. Earl Barnes writes of England, and finds our national activities taking traditional forms—Royal commissions, congresses, inter-departmental committees. Public interest in psychological questions is steadily growing in our country, forced upon us "by a disorganised school system, by industrial stagnation and an army of unemployed people, by the agitation for woman's suffrage and by the unrest in India." Truly outsiders see most of the game!